

Data Replication in the CNR Environment:

The Harsh Reality of a Harsh Communications Environment

presented by

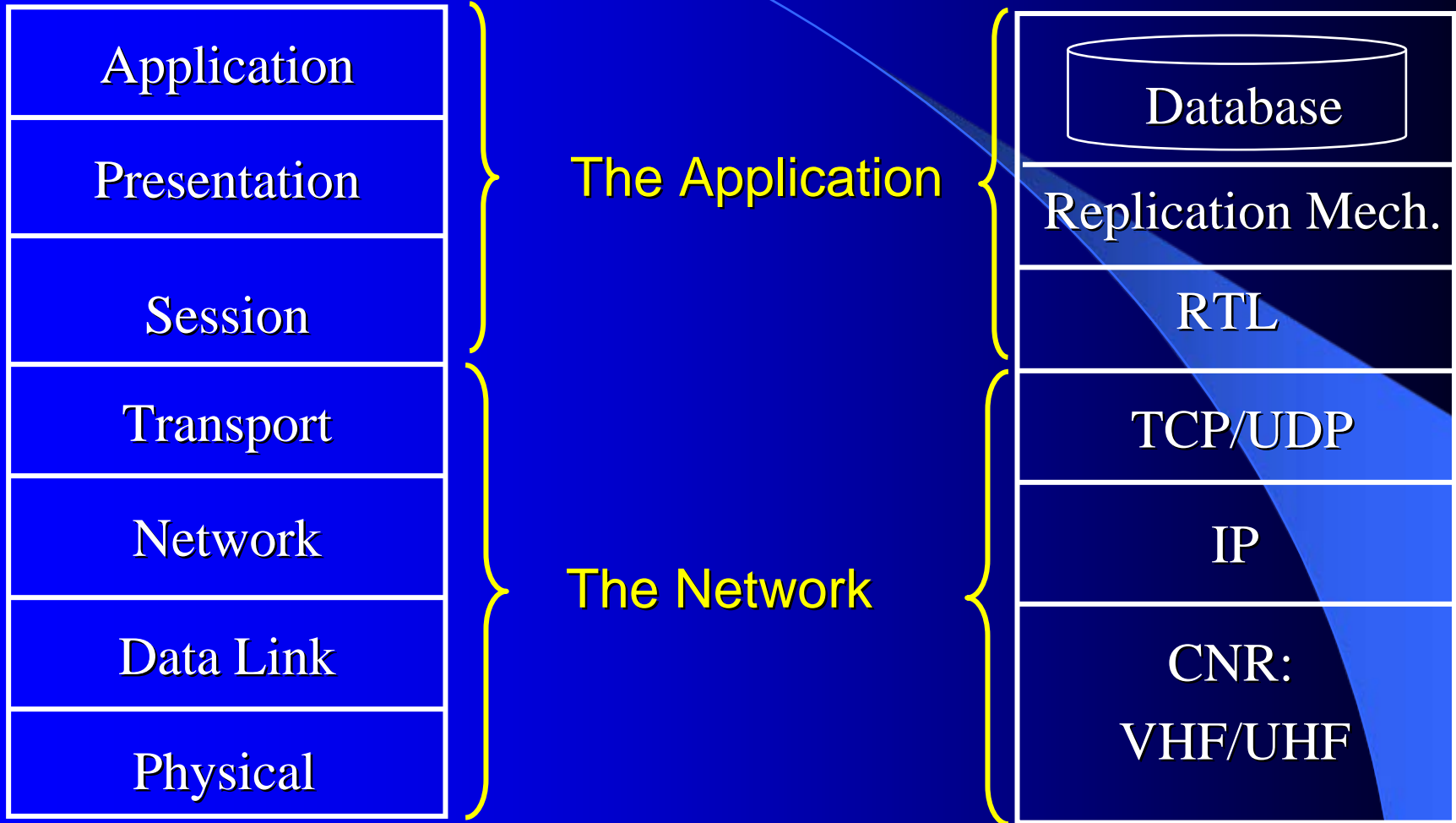
Tim Johnson, IP Unwired

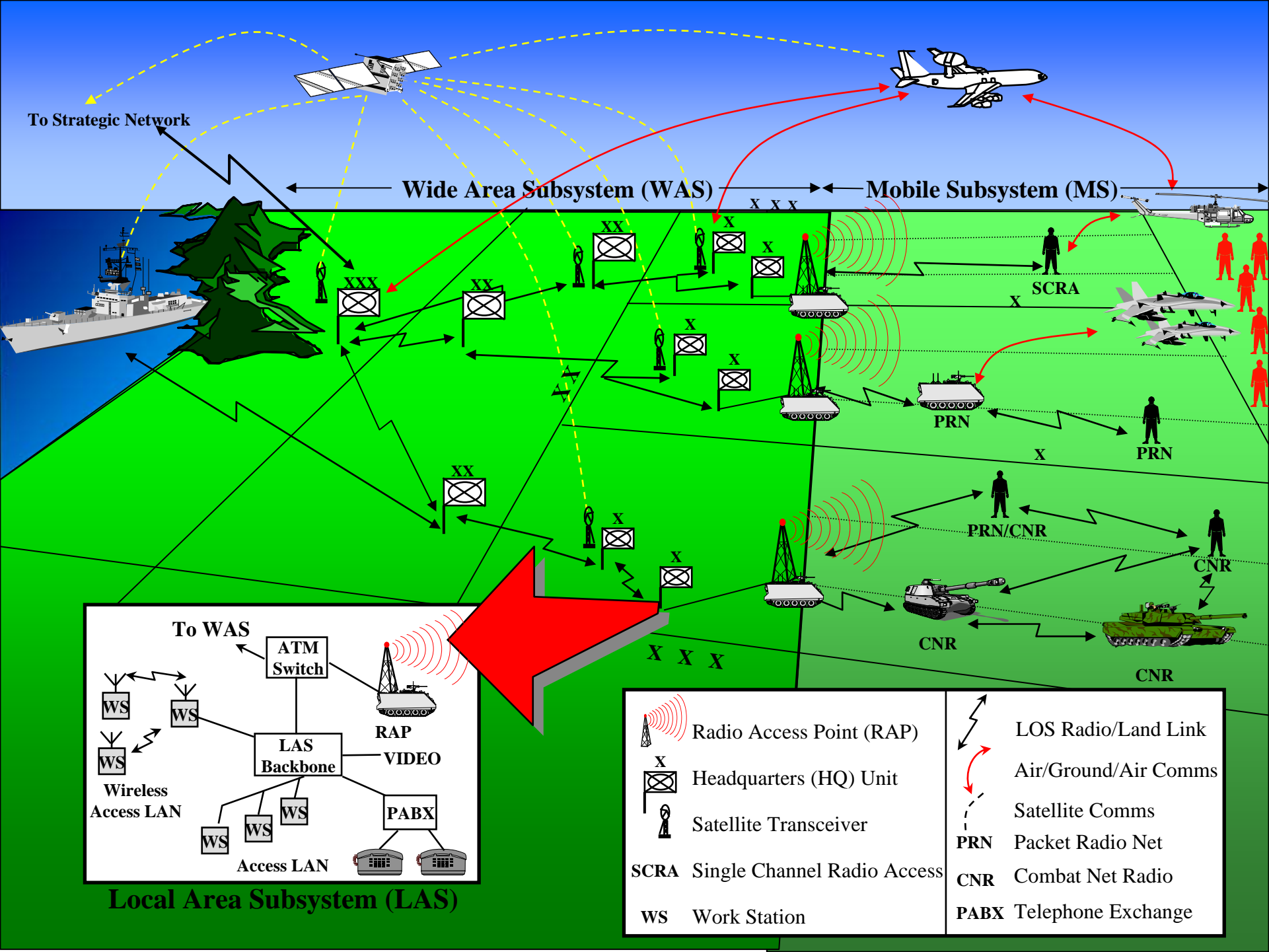
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Outline

- The Requirement – C4ISR(C2IS).
- The CNR Environment.
- TCP/IP Performance.
- Data Replication & Replication Transport Mechanisms.
- RTL Design Considerations.
- Low Bandwidth Test Bed – DRDC Valcartier.
- Conclusion.

Terminology





To Strategic Network

Wide Area Subsystem (WAS)

Mobile Subsystem (MS)

SCRA

PRN

PRN

PRN/CNR

CNR

CNR

CNR

To WAS

ATM Switch

RAP

VIDEO

LAS Backbone

Wireless Access LAN

Access LAN

WS

WS

WS

WS

WS

WS

PABX

PABX

Local Area Subsystem (LAS)



Radio Access Point (RAP)



Headquarters (HQ) Unit



Satellite Transceiver

SCRA Single Channel Radio Access

WS Work Station



LOS Radio/Land Link



Air/Ground/Air Comms



Satellite Comms



PRN Packet Radio Net



CNR Combat Net Radio



PABX Telephone Exchange

The Requirement

- Migration of C2ISs to FEBAw where CNR is primary comms.
- DBMSs with Replication to partially replace/supplement MMHS.
- International programs like ATCCIS/MIP are moving in this direction.

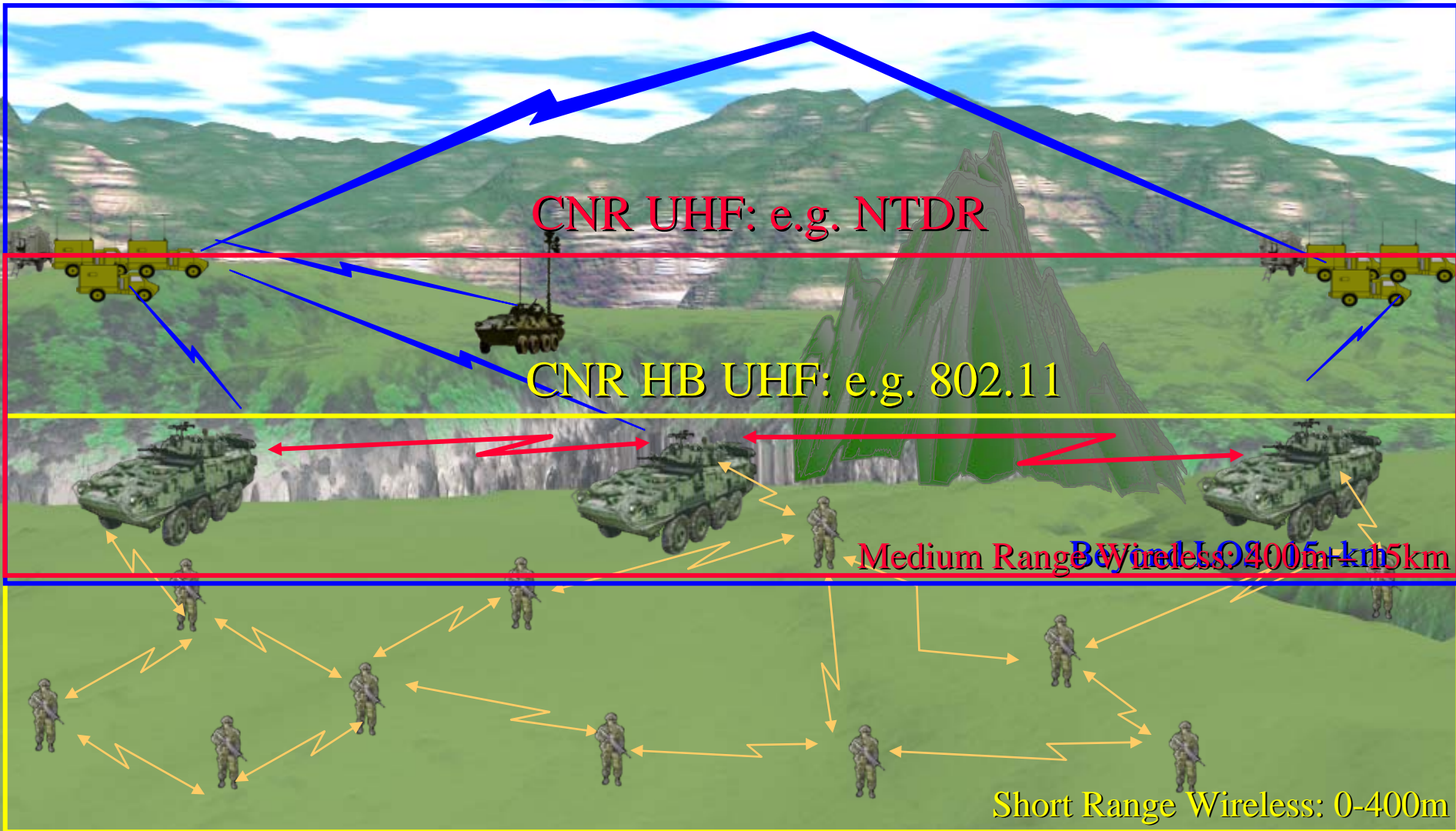
CNR VHF: e.g. CNR(P), SINGARS

CNR UHF: e.g. NTDR

CNR HB UHF: e.g. 802.11

Medium Range Wireless: 400m-15km

Short Range Wireless: 0-400m



CNR Domain

- VHF: Vast Majority of radios capable of 16kbps half duplex.



- UHF: Radios capable of 288kbps full duplex.



- High Band UHF: (e.g. 802.11) capable of 11 Mbps.

CNR – VHF (Cdn Example)

- Reality: usable throughput at the application layer is a fraction of the base rate:

CNR(P) – Max throughput on DATA ONLY network: $\sim 1\text{kbps}$

SHARED AMONGST USERS

$\rightarrow 25 \text{ radios/net} = 40 \text{ bps/user}$

- Reality: residual BER as low as 10^{-5}
- Other VHF CNR radios have similar performance

CNR – UHF (225-450Mhz)

- NTDR – 288 kbps is for ‘well situated’ sites
- Reality: truly tactical environment performance is approximately:
 - ✦ ~16kbps from 22kbps link; and
 - ✦ ~80kbps using a 100 kbps link;
- Available throughput is still shared amongst users ($80\text{kbps}/25 = 3.2 \text{ kbps}$).
- Error conditions similar to VHF

CNR – High UHF (2.4 GHz)

- 802.11 – 11,5,2, & 1 Mbps
- Throughput at application layer is ~50% of stated maximum (with AP).
- Throughput significantly effected by:
 - ✦ Speed of units (36km/h = ~50% cut) ; and
 - ✦ Foliage/Antenna position;
- Higher rates not realistic in tactical domain



TCP

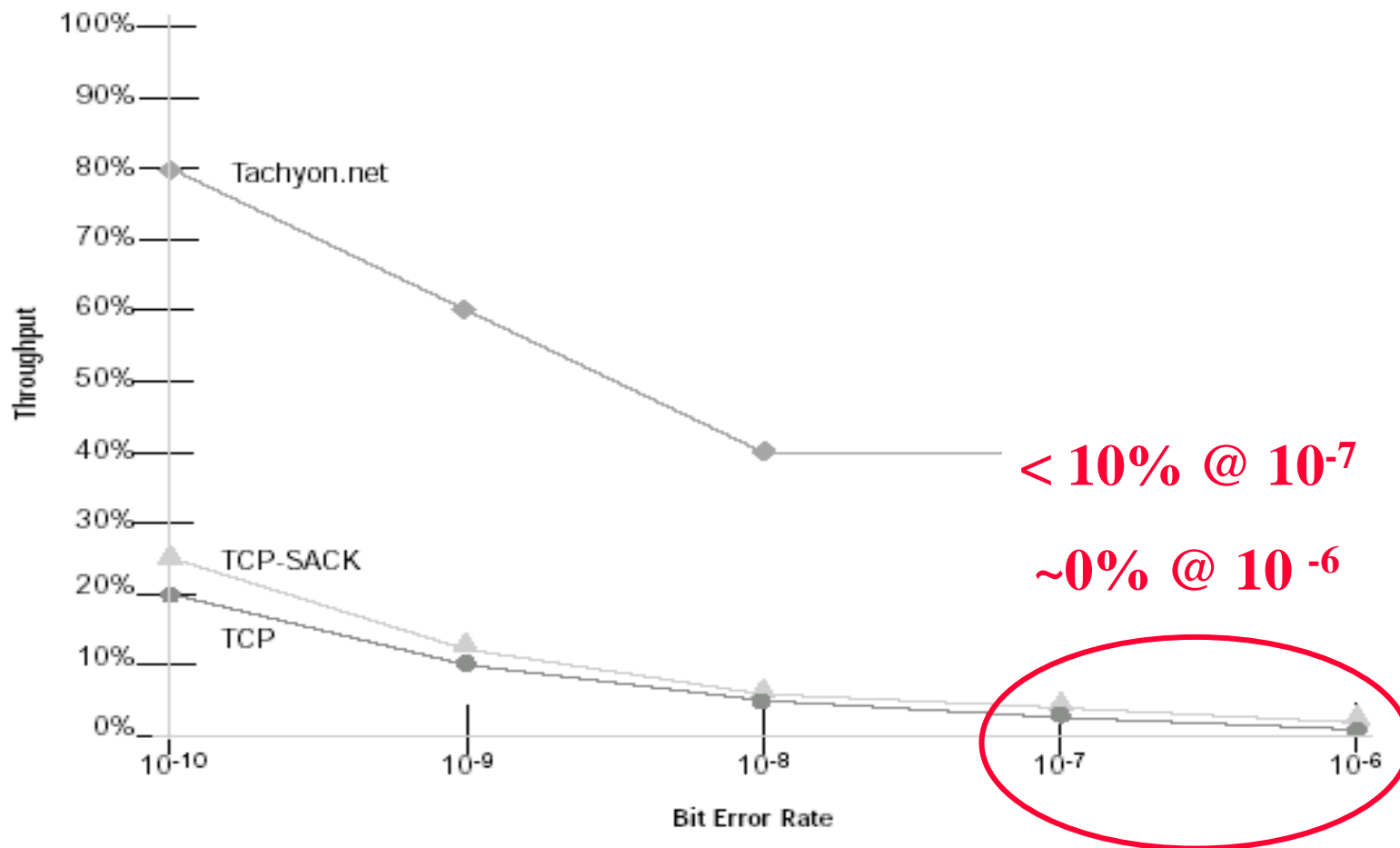
- TCP was designed for wired networks →:
 - ◆ All controls designed for congestion, not errors →
 - ◆ TCP is very sensitive to BER and Latency →
 - ◆ Error in wireless domain trigger TCP congestion controls (e.g. 1 packet lost = 50% cut in tx rate)
 - ◆ TCP is connection-oriented → in wireless tact. domain (high BER, latency, long fades) TCP connections timeout regularly

TCP

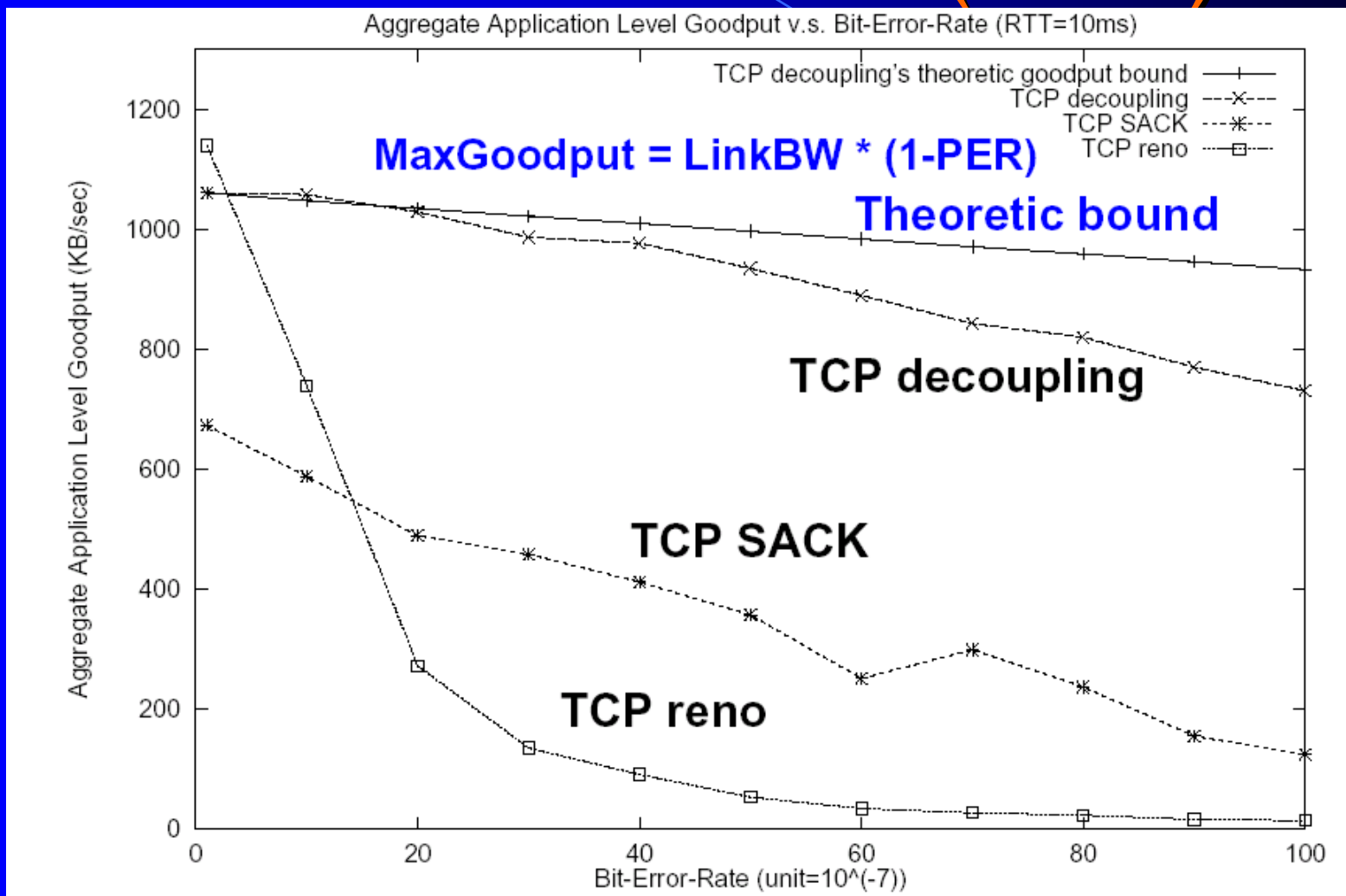
- THEREFORE:

Standard TCP is non-functional in most tactical wireless environments!!

TCP and BER



TCP and BER (con't)



Data Replication & the RTL

- Topology: Master/Slave, Peer-to-Peer
- Replication Transport Layer:
 - ✦ Synchronous – i.e. two-phase commit
 - ✦ Asynchronous – Periodic/Aperiodic

All commercial RTLs use TCP!
(No acceptable loss of data!!)

RTL for Tactical Comms.

- RTL must meet the requirements of IM and the capabilities of the network.
- IM Requirements affecting the RTL:
 - ✦ Requirement to distribute data for operational purposes (e.g. position updates, compensate for losses)
- Network Capabilities affecting the RTL:
 - ✦ Shared media (e.g. inherent broadcast)
 - ✦ High Error and Latency; and
 - ✦ Relatively low throughput.
 - ✦ Unreliable links (e.g. prolonged fade)

RTL – Design Criteria

- The RTL should:
 - ✦ Take advantage of the shared media aspects;
 - ✦ Be able to tolerate loss and high delay;
 - ✦ Compensate for radio link loss;
 - ✦ Ensure max. communications efficiency while providing guaranteed level of service for prime data;
 - ✦ Be independent of the DM used;
 - ✦ Use a standard, connectionless transport layer; and
 - ✦ Be able to detect and route certain data to other units who enter the network.

LBTB - Background

IRIS Corrective Options:

• Increase Network Throughput:

- ✦ Modify RDL;
- ✦ Data compression;
- ✦ Production of high-rate VHF modem;
- ✦ Purchase new data radio (e.g. NTDR); and
- ✦ Separate voice and data networks.

• Information Management

- ✦ ‘The right information, to the right user, at the right time’
- ✦ Data Fusion, Streamlining, Priority Levels, Data Replication, DBMS Triggers and Stored Procedures etc.

Test Bed Objective

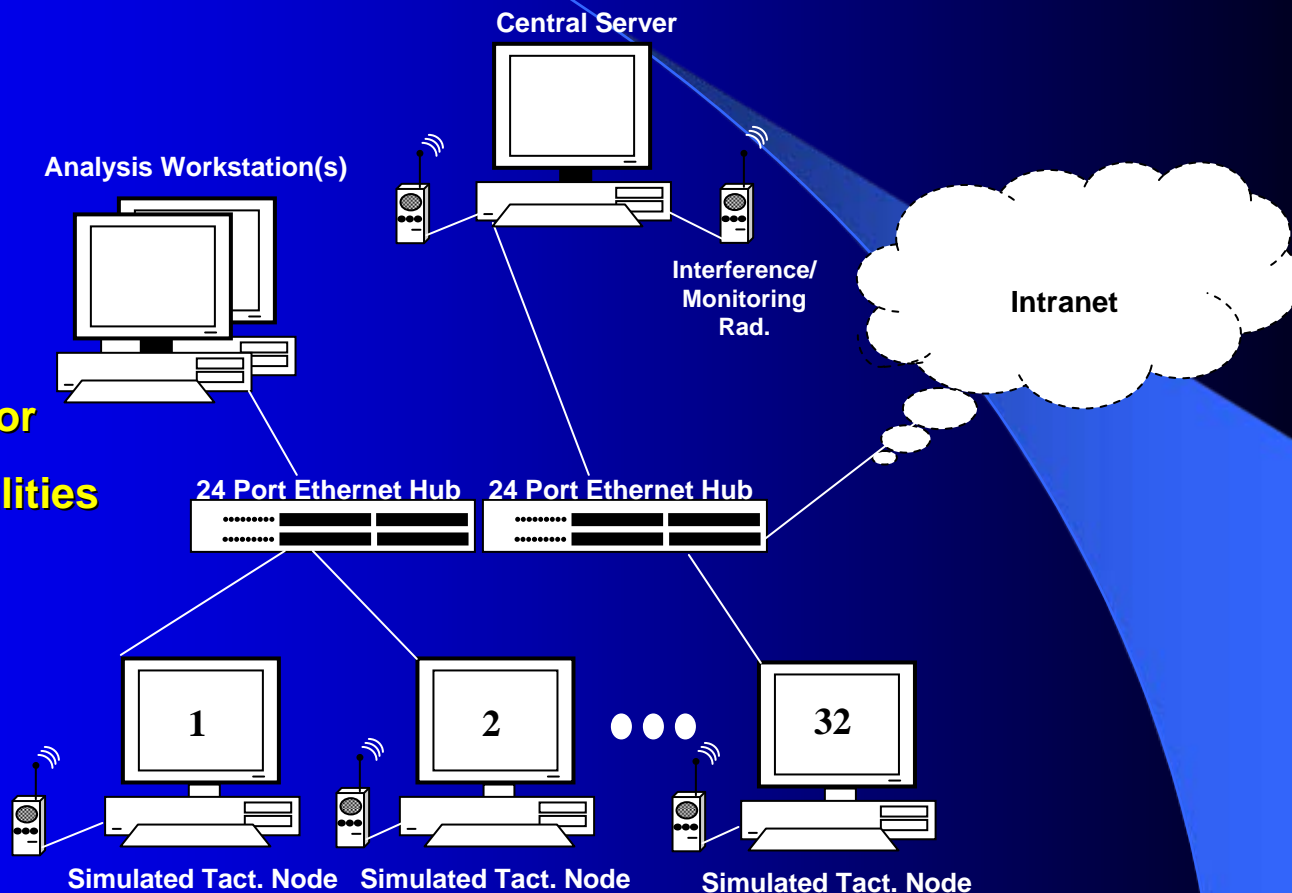
To:

- a. **Design;***
- b. **Build;***
- c. **Test; and***
- d. **Install***

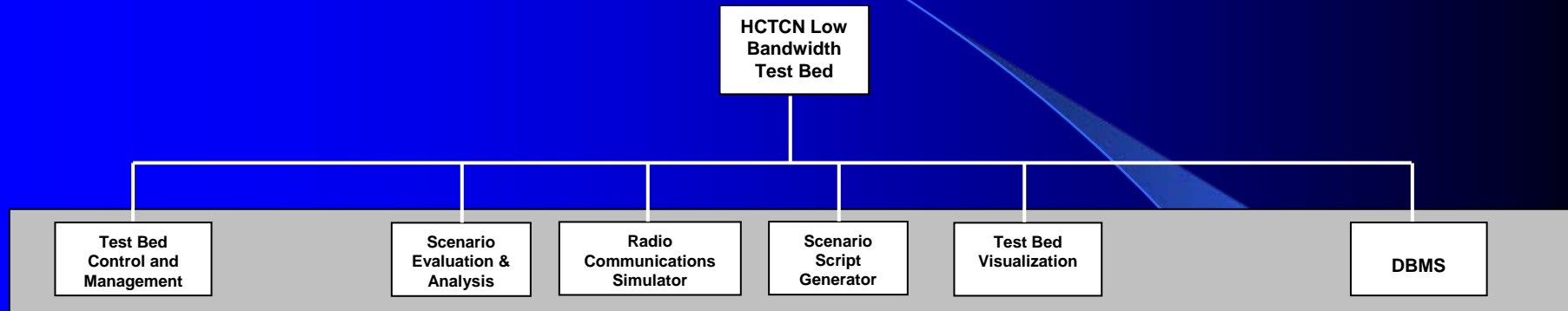
a research test bed to evaluate battlefield IM strategies applied in a low bandwidth tactical wireless communications environment.

System Overview

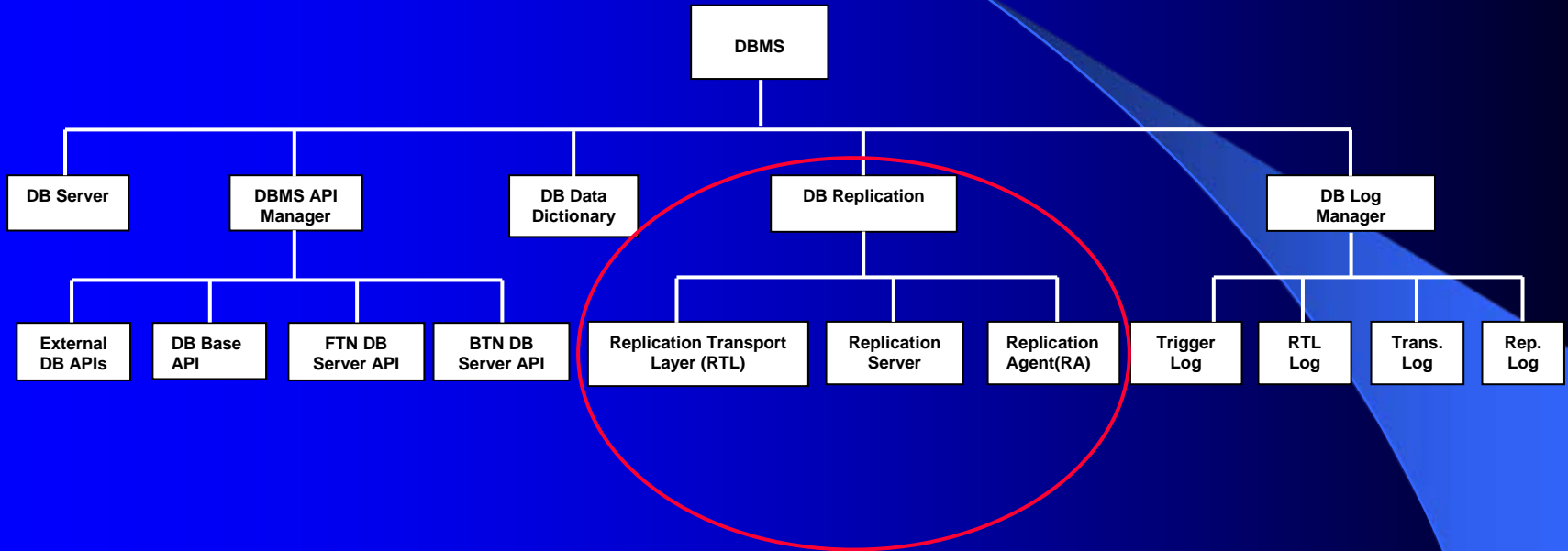
1. **Traffic Source/Sink**
2. **Comms Sys. Simulator**
3. **Measurement Capabilities**



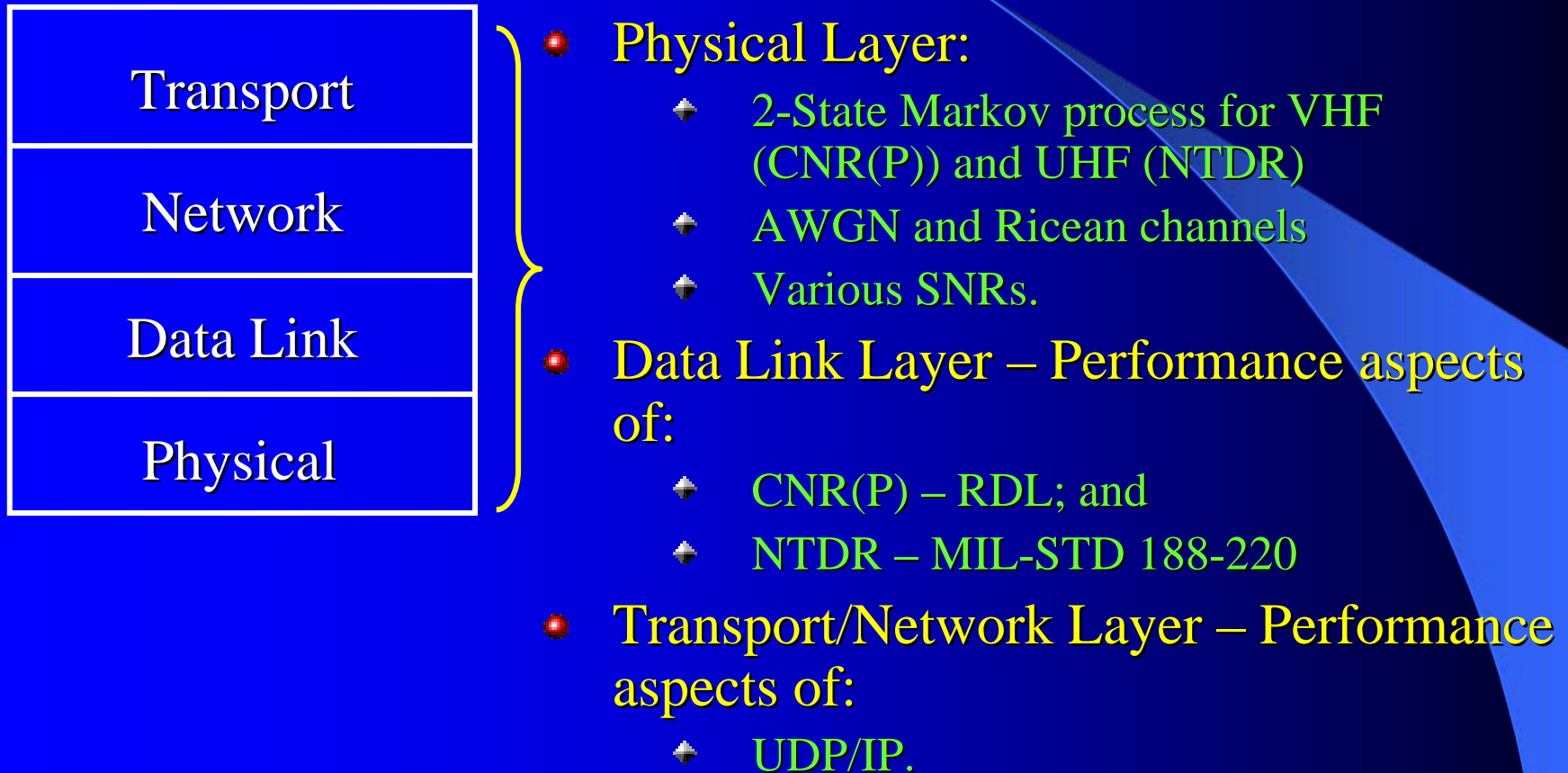
High-Level Functional Architecture



DBMS – DB Replication



Radio Communications Simulator



File Edit View					View
Event	Scenario Time	Node ID	Action/Message/Vector	Parameter	
114	10:35.00	STN01	Enemy Report	Pos:35.09, 115.03; T-72, Qty:3;Ar	D+10:35.00; # 114
115	10:35.15	STN06	Enemy Report	Pos:35.09, 115.06; T-72, Qty:5;Ar	D+10:35.15; # 115
116	10:37.00	STN04	Position Report	Pos:32.02, 114.03; STN04;10:37;	D+10:37.00; # 116
117	10:38.00	BKGND01	Vector Movement 3/32	Pos:31.02, 115; Sp:32km/h;10:38	D+10:38.00; # 117
118	10:38.30	STN06	Fire Mission	Pos:35.09, 115.03; Ord:105mm	D+10:38.30; # 118
119	10:39.00	STN18	Regular Position Report 13/64	Pos:30.09, 112.03; STN18; 10:39;	D+10:39.00; # 119
120	10:39.23	BKGND02	Vector Movement 16/87	Pos:32.02, 113; Sp:16km/h;10:39.	D+10:39.23; # 120
121	10:40.02	STN06	Fire Mission	Pos:35.08, 115.02; Ord:105mm	D+10:40.02; # 121
122	10:40.37	STN01	Enemy Damage Report	Pos:35.08, 115.02; T-72, Qty3;Ar	D+10:40.37; # 122
123	10:41.14	BKGND01	Vector Movement 4/32	Pos:31.03,115.01;Sp:32km/h;10:4	D+10:41.14; # 123
124	10:41.32	STN14	Enemy Report	Pos:35.09, 115.03; Mech Inf;40;	D+10:41.32; # 124

Input Mode: New Event

Node:

STN01

▼

Add New

STN03

STN04

BKGND01

BKGND02

▼

Time:

10:42.00

▼

Action/Message/Vector Type:

Position Report

▼

Enemy Situation Report

Vector Movement

Regular Position Report

Fire Mission

▼

Parameters:

X-Coordinate:

▼

Y-Coordinate:

▼

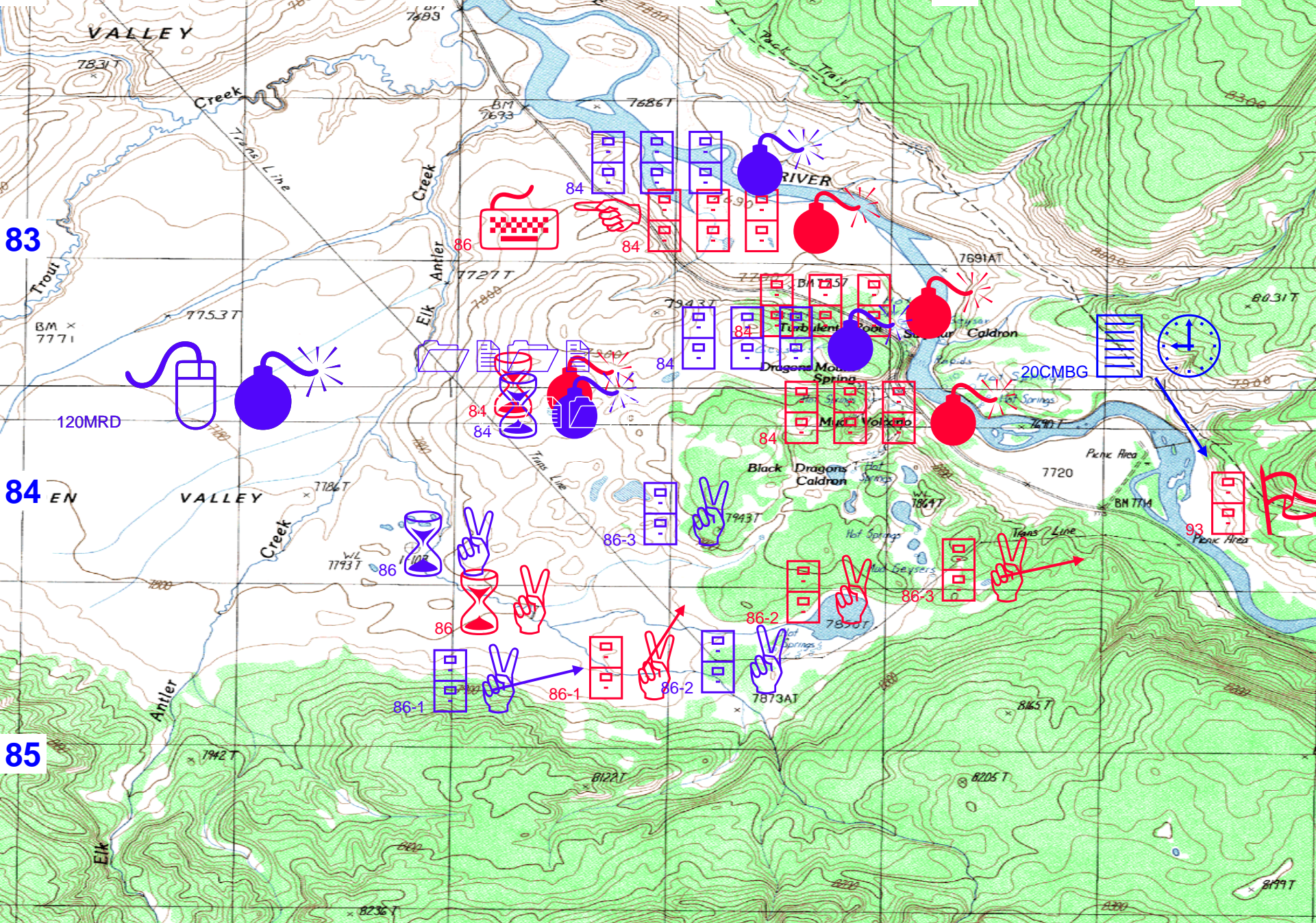
Z-Coordinate:

▼

View

- D+10:35.00; # 114
- D+10:35.15; # 115
- D+10:37.00; # 116
- D+10:38.00; # 117
- D+10:38.30; # 118
- D+10:39.00; # 119
- D+10:39.23; # 120
- D+10:40.02; # 121
- D+10:40.37; # 122
- D+10:41.14; # 123
- D+10:41.32; # 124
- D+10:42.00; # 125
- D+10:42.43; # 126
- D+10:43.04; # 127
- D+10:43.17; # 128
- D+10:43.17; # 129
- D+10:43.19; # 130
- D+10:43.22; # 131
- D+10:43.23; # 132
- D+10:43.30; # 133
- D+10:44.01; # 134
- D+10:44.14; # 135
- D+10:44.22; # 136
- D+10:44.29; # 137
- D+10:44.36; # 138
- D+10:47.52; # 139
- D+10:4757; # 140
- D+10:48.12; # 141
- D+10:49.44; # 145
- D+10:49.54; # 146
- D+10:51.29; # 147
- D+10:54.36; # 148
- D+10:54.55; # 149
- D+10:57.57; # 150

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Conclusion

- Data Replication in CNR environment (VHF, UHF) requires redesign of RTL
- RTL must consider:
 - ◆ Operational requirements for data distribution; and
 - ◆ Capabilities/Constraints of VHF/UHF media
- LBTB has design and will implement a unique RTL for this environment.

Question

